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(54) **HIGH-STRENGTH LOCK, METHOD OF MAKING HIGH-STRENGTH LOCK, AND METHOD FOR MOUNTING HIGH-STRENGTH LOCK**

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(56) **References Cited**

U.S. PATENT DOCUMENTS

2,255,402	A	9/1941	Vile	
2,487,803	A *	11/1949	Heimann	411/517
3,102,412	A *	9/1963	Christopher	70/379 R
3,173,466	A *	3/1965	Starriett et al.	411/304
3,190,092	A *	6/1965	Patriquin	70/370
3,408,840	A *	11/1968	Hasenbein	70/369
3,600,912	A *	8/1971	Foreman	70/371
3,702,553	A	11/1972	Nolin	
3,789,638	A *	2/1974	Roberts et al.	70/368
5,152,161	A *	10/1992	Lee	70/379 R
5,279,138	A *	1/1994	Gallagher	70/369
5,435,159	A *	7/1995	Ramsauer	70/370

(Continued)

FOREIGN PATENT DOCUMENTS

WO WO 2008/080095 A2 7/2008

OTHER PUBLICATIONS

PCT Search Report and Written opinion for International Application. No. PCT/US07/088641, mailed Sep. 24 and Sep. 29, 2008 (7 pages).

(Continued)

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(57) **ABSTRACT**

Described herein is locking apparatus, method for making a locking apparatus, and method for mounting a locking apparatus to the door of a personal storage container. The locking apparatus may include a threaded portion having deformed threads and a lock body shape to fit a restrictive mounting hole.

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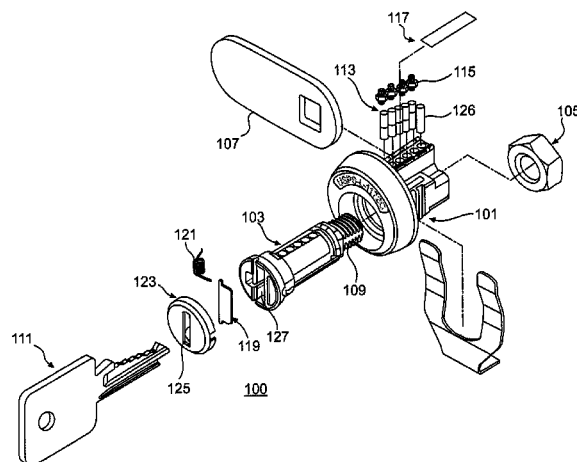
**E05B 17/04** (2013.01); **E05C 3/042** (2013.01);

**Y10T 70/5093** (2015.04)

(58) **Field of Classification Search**

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70/490, 373

See application file for complete search history.



(56)

**References Cited**

## U.S. PATENT DOCUMENTS

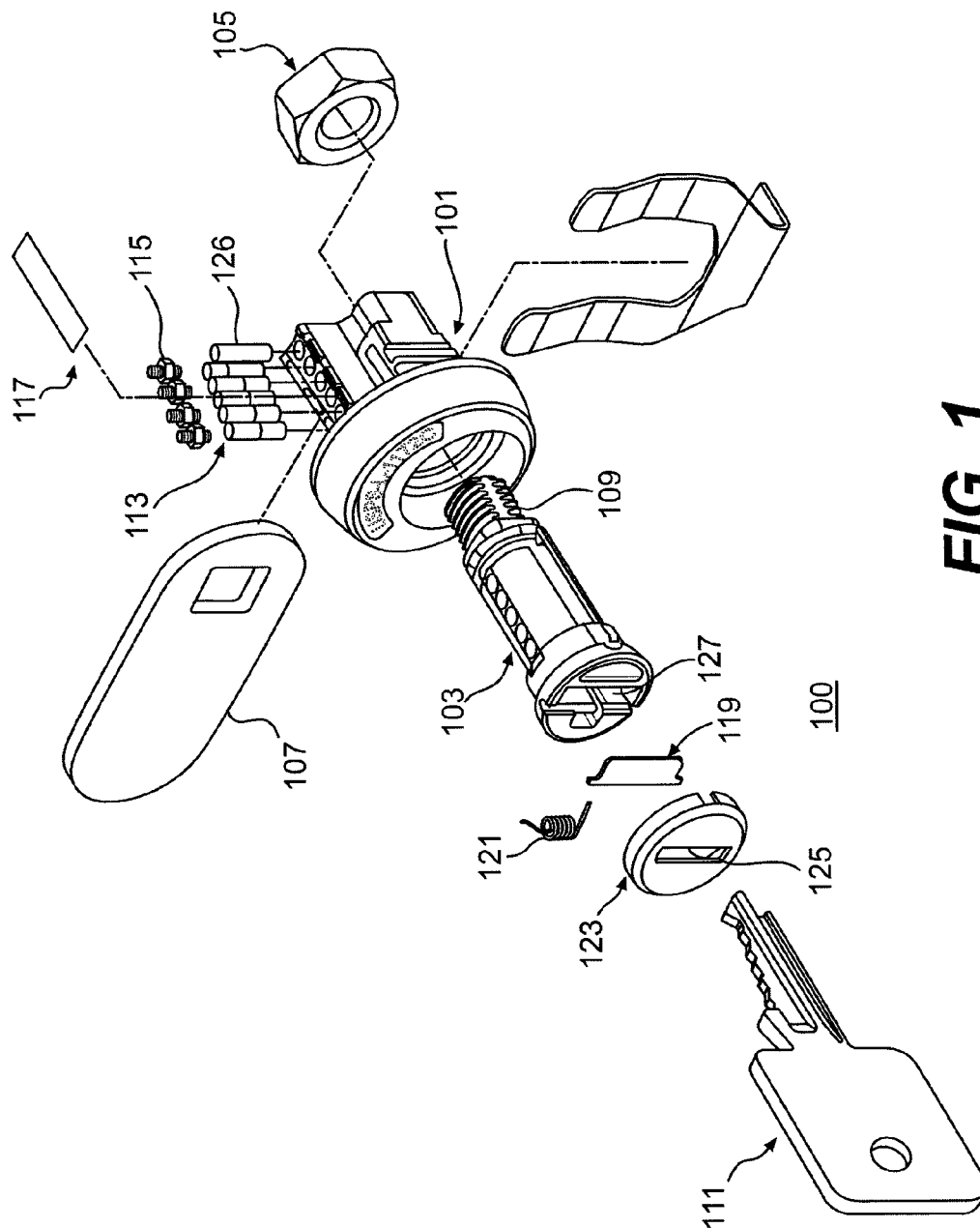
5,479,800 A \* 1/1996 Myers ..... 70/365  
 5,491,993 A 2/1996 Anderson  
 5,685,184 A 11/1997 Gallagher  
 5,713,708 A \* 2/1998 Van derDrift et al. .... 411/208  
 6,012,311 A 1/2000 Duckwall  
 6,155,090 A 12/2000 Rubensson  
 6,508,092 B1 1/2003 Laabs  
 6,514,025 B2 \* 2/2003 Watanabe ..... 411/311  
 7,003,994 B2 2/2006 Ruan  
 7,194,876 B1 3/2007 Pacheco et al.  
 7,251,970 B2 \* 8/2007 Mielonen ..... 70/371  
 D692,744 S \* 11/2013 Dalton ..... D8/331

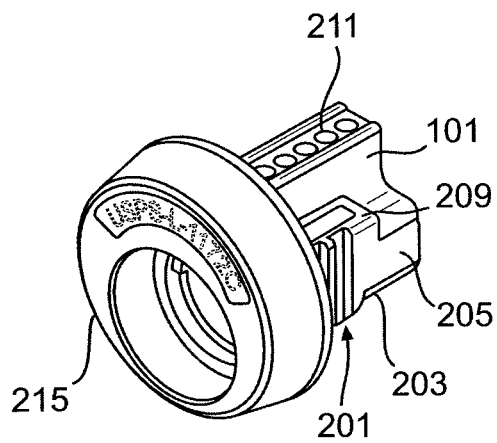
2002/0104344 A1 \* 8/2002 Nieves ..... 70/370  
 2006/0137416 A1 \* 6/2006 Chang ..... 70/417

## OTHER PUBLICATIONS

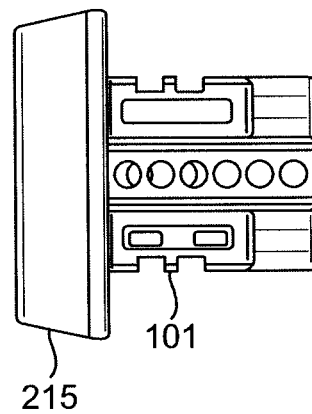
United States Postal Service Specification Patron Lock, Centralized  
 Delivery Equipment (CDE) (PSIN 0910A & B) (7 pages).  
 Ad: New Jul. 2006, CompX National New Postal Locks (1 page).  
 Ad: Introducing New Postal Locks CompX National (1 page).  
 Federal Register: Sep. 3, 2004 (vol. 69, No. 171)] [Rules and Regu-  
 lations] [pp. 53808-53834] (28 pages).  
 International Preliminary Report on Patentability, dated Jul. 2, 2009,  
 for PCT application No. PCT/US2007/088641, filed Dec. 21, 2007 (8  
 pages).

\* cited by examiner

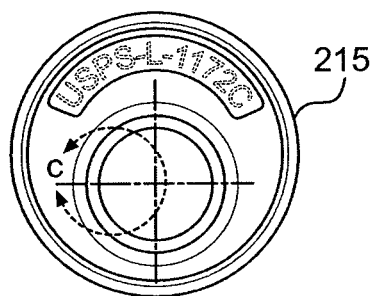




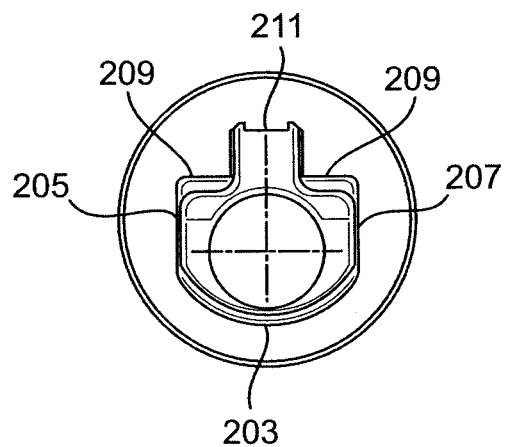
**FIG2(a)**



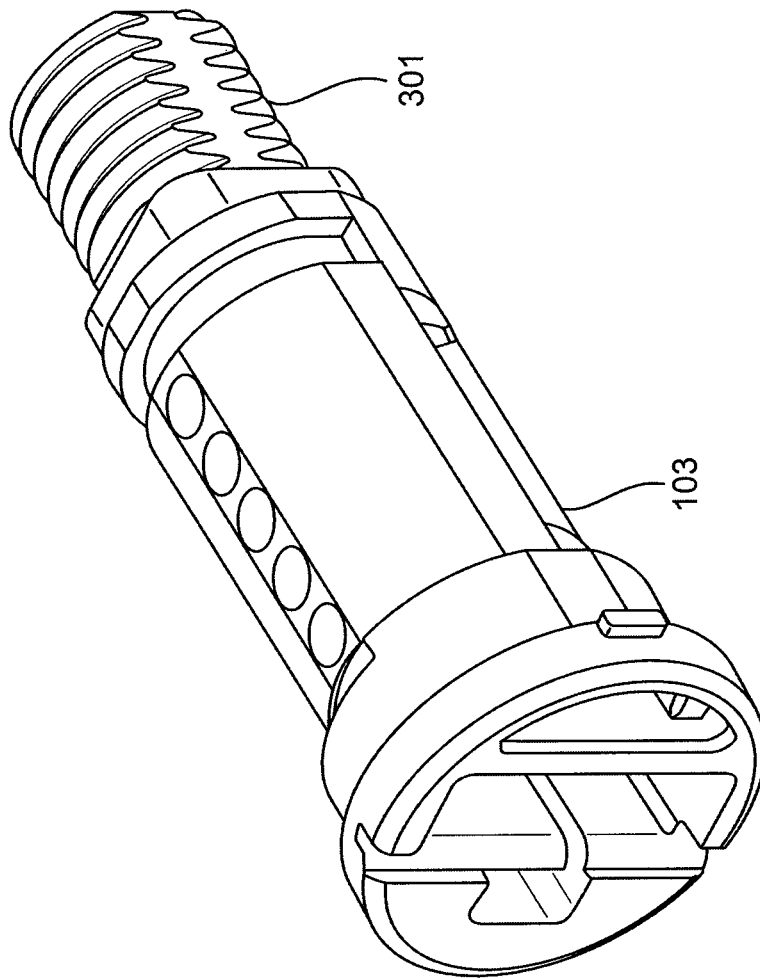
**FIG2(b)**



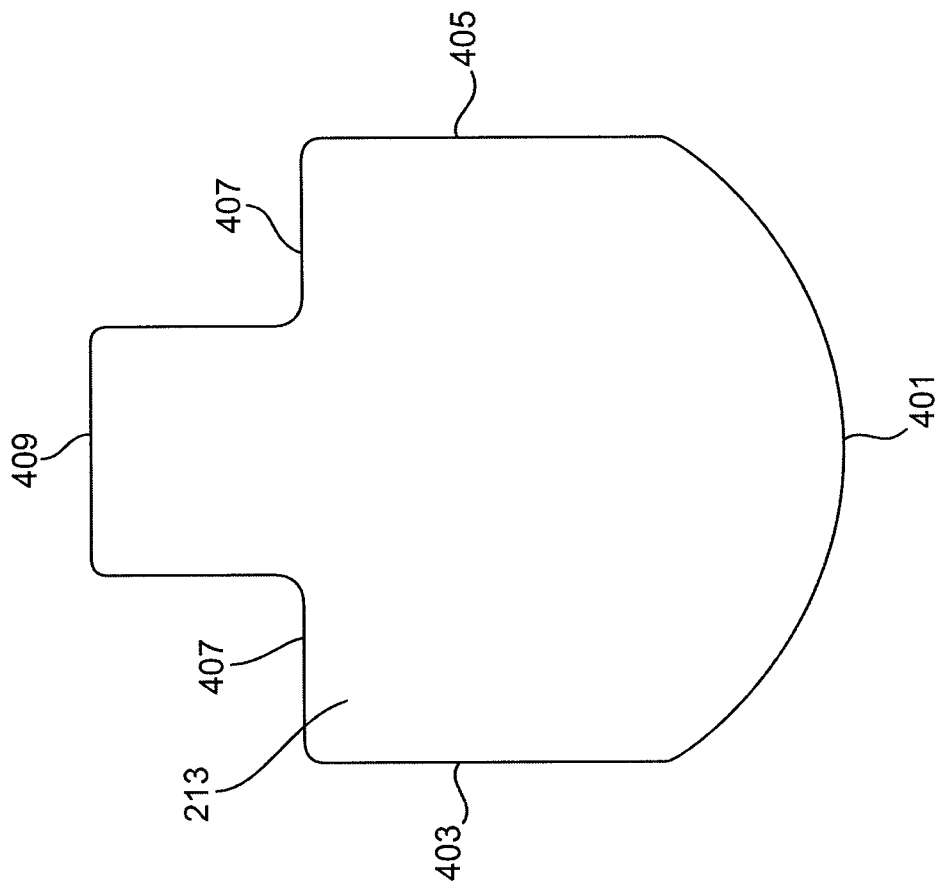
**FIG2(c)**



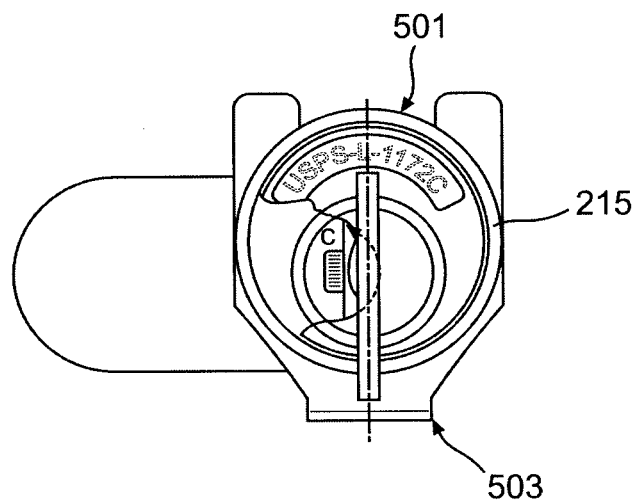
**FIG2(d)**



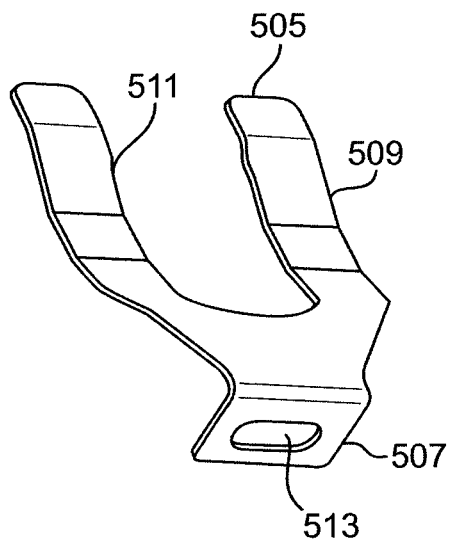
**FIG. 3**



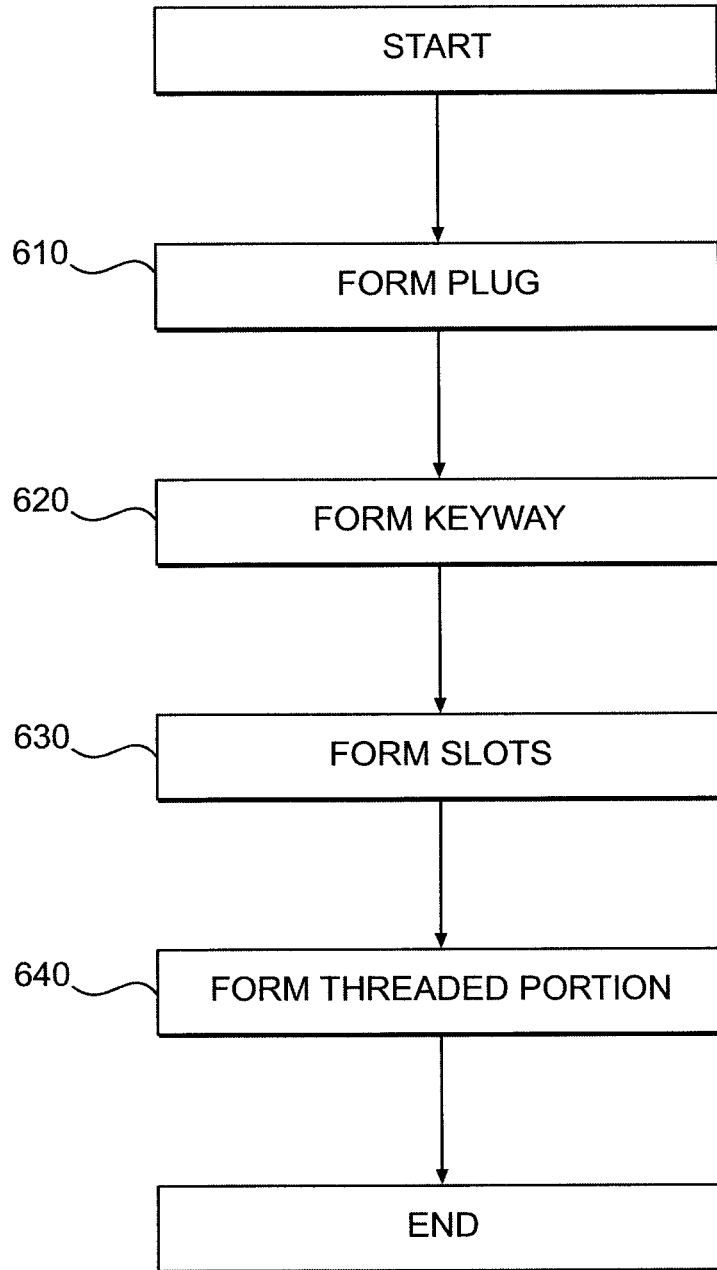
**FIG. 4**



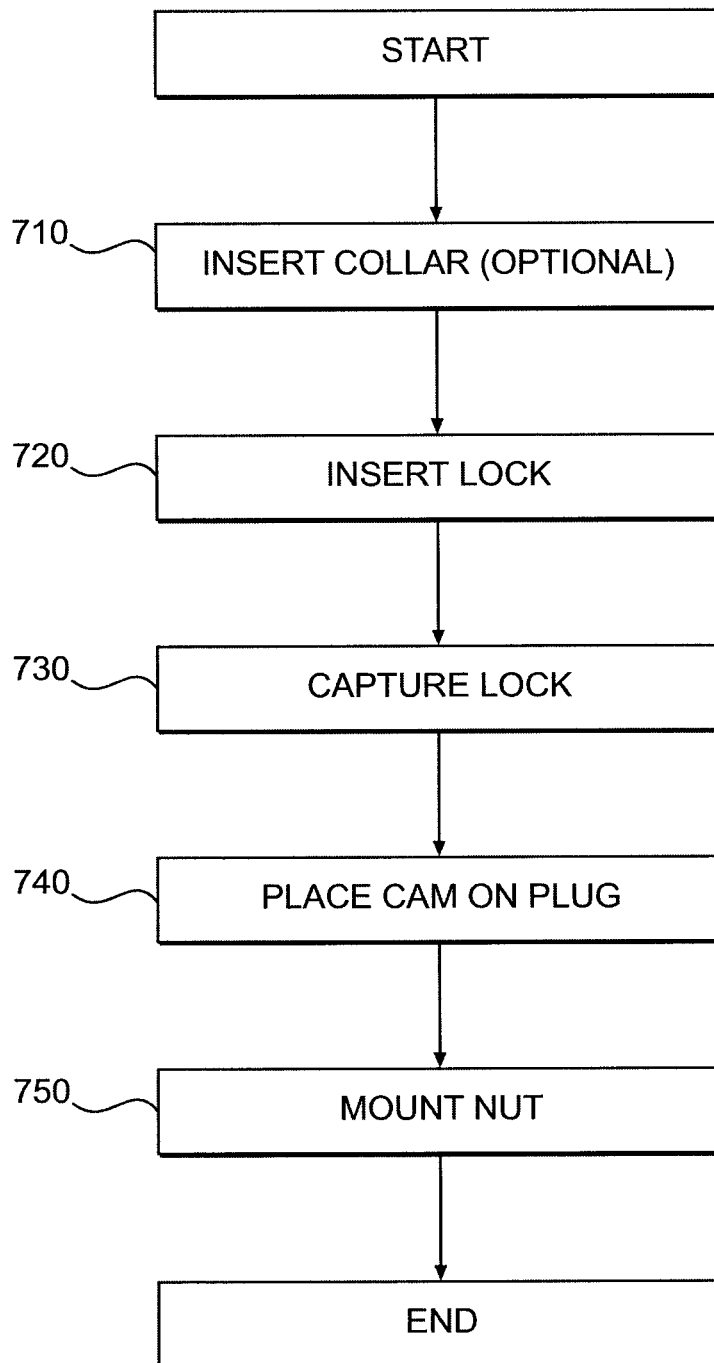
**FIG 5(a)**



**FIG 5(b)**

**FIG. 6**



**FIG. 7**

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# **HIGH-STRENGTH LOCK, METHOD OF MAKING HIGH-STRENGTH LOCK, AND METHOD FOR MOUNTING HIGH-STRENGTH LOCK**

## **RELATED APPLICATIONS**

The present application hereby claims the benefit of U.S. Provisional Patent Application Ser. No. 60/876,167, which was previously filed by the same inventors on Dec. 21, 2006.

## **TECHNICAL FIELD**

This invention relates generally to locking improvements for security of patron storage devices, and, more particularly to a locking apparatus and method that provide increased security of patron storage devices by withstanding high cantilevered load requirements while also meeting a high threshold corrosion resistance requirement using commonly available, cost-effective parts.

## **BACKGROUND**

The incidence of theft from personal storage containers is on the rise. For example, the number of reported attacks on wall-mounted personal mail storage containers increased from 988 in 2000 to 2,819 in 2002.<sup>1</sup> This increase in the number of thefts from wall-mounted personal storage containers highlights the need for improvements in the securing of personal storage lockers and delivered-goods lockers. This need for improvement also exists due to the potential for identity theft and loss of personal privacy, which result from theft in general.

Visual inspection, forensic analysis, and engineering testing measures of locks and storage containers have demonstrated that improvements in locks and storage containers could increase the security of items placed within the storage containers. With the rise in incidences of identity theft, improvements in security of personal information also becomes more important. As more and more goods are purchased through the Internet and shipped directly to a purchaser, securing of these delivered valuables becomes more important. Better equipment would improve the security of valuables and personal information within the storage container from theft.

Conventional methods of compromising and/or breaking into the storage containers are well documented. Methods include prying open the door of such containers with a flat head screw driver and gripping the cylinder collar of the locker lock with vise grips to remove the lock with torsion force.

A multitude of mechanical failures can occur upon application of a low cantilever load to the door of the storage container or upon the application of a low cantilever load to the lock itself. For example, fracture of the cam end of the lock plug may occur, causing the door to open. Other possible mechanical failures include fracture of the plug body and severing of the end of the cam from the plug. This latter mechanical failure also results in the door opening.

Similarly, compromising the security of the storage container via gripping the cylinder collar with vise grips and removing the lock with torsion force can lead to a multitude of mechanical failures. For example, under torsion, mechanical failures may include the loosening of the plug nut, which allows the cam to rotate more freely and the lock to open. The plug nut may also completely disengage from the bolt, resulting in the cam falling off the end of the plug. Because the cam

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engages the frame of the storage container or equivalent and prevents the door from opening, when the cam falls off the plug, the door readily opens.

Previous solutions to the problem of increasing the security of storage containers include the United States Postal Service ("USPS") USPS-L-1172C version lock and associated locker system. The USPS-L-1172C lock can withstand a previously unachievable 1000-pound cantilever load requirement, an increase of 800% over earlier personal storage container locks. The USPS-L-1172C's plug design and cylinder could withstand the resultant forces of a 1000-pound cantilever load on a lock installed in a personal storage locker.<sup>2</sup> This 1172C version lock also can withstand 1000-pound load applied to the cam, which is the part of the apparatus attached to the threaded end of the plug.

<sup>2</sup> The plug is the center rotating piece of a lock into which the key is inserted. The cylinder is the stationary piece of the lock that houses the plug and interfaces with the storage container door.

The 1172C meets the 1000-pound criteria with room to spare. Both the material and design contributed to the improved performance of the 1172C. The previous low-cost, but low-strength Zinc die-cast material for the plug was changed to a metal injection molded, precipitation hardened, stainless steel material. Manufacturing the plug in this way resulted in a  $\frac{3}{16}$ s thread of extreme strength on the plug without requiring any secondary machining processes. Additionally, manufacturing the plug this way had the additional advantage of being reasonably economical.

Design changes to meet the 1000-pound load criteria in the 1172C over previous versions included a locking plug nut. Because of this nut, the USPS-L-1172C could withstand aggressive torque load to its face without becoming loose or disassociated from the personal storage device. The USPS-L-1172C locking apparatus comprised a locking plug nut, which did not back off of the end of the plug bolt with vibration, cantilever load on the door of the storage container, or tensile load to the face of the cylinder.

Despite the great strength of the 1172C, increased strength and increased life may be warranted in locations known to have a high incidence of theft. Further, some environmental conditions require an increased resistance to corrosion. Changes in the existing lock apparatus are therefore desirable to meet higher break-in load criteria and increased corrosion resistance criteria.

The 1172C version of the plug specified a standard thread form that required a thread-locking style plug nut to provide adequate "grip" of any installed cam and also required a specialized version of one specific self-locking style nut that had been the only successful version to test out at load values exceeding the 1000-pound requirement. This superior strength performance came at a price of unexpected installation issues, however. In particular, the torque required to completely seat this self-locking nut exceeded, for most installers, the amount of torque that could be generated by previous standard installation methods and tools, for example a nut driver. Accordingly, it was sometimes necessary for installers to use a ratchet nut driver to properly install the prior art lock system. Thus, it is desirable to use a widely available standard nut as a plug nut, as opposed to the self-locking version used on the plug of the 1172C lock, enabling maintenance personnel to install a new lock with only a nut driver. It is further desirable to use less expensive plug nuts available in great numbers for convenience and cost efficiency.

Accordingly, it is desirable to provide a lock, locking method, and locking system that meets high load and corrosion resistance criteria. Moreover, it is desirable to provide a lock, a locking method, and a locking system that allows for

installation of a new lock with only a nut driver. Finally, it is desirable to provide a lock, locking method, and locking system using widely available and cost-effective nuts.

### SUMMARY

A locking apparatus for locking a box using a cam comprises a cylinder, a rotatable plug positioned inside the cylinder, a pin assembly for receiving a key to selectably prevent and permit rotation of the plug, and a nut cooperating with the threaded portion of the plug to capture the cam. The plug comprises a threaded portion. The threaded portion comprises a deformed portion providing a retention force between the threaded portion of the plug and the nut to resist removal of the nut from the threaded portion.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention, as claimed.

### BRIEF DESCRIPTION OF THE DRAWINGS

The drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description, serve to explain the principles of the invention. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

FIG. 1 is an exemplary lock with its constituent components consistent with the present invention.

FIGS. 2(a)-(d) depict various views of a cylinder of the lock of FIG. 1.

FIG. 3 depicts an exemplary plug for use in the lock of FIG. 1.

FIG. 4 depicts an exemplary restrictive mounting hole pattern for use in the lock of FIG. 1.

FIGS. 5(a)-(b) depict the lock of FIG. 1 mounted with an exemplary retaining clip.

FIG. 6 is a flow chart of the operational steps of one exemplary method consistent with the present invention.

FIG. 7 is a flow chart of the operational steps of a second exemplary method consistent with the present invention.

### DESCRIPTION OF THE EMBODIMENTS

#### Operational Principles of Cylinder Locks with Pin-and-Tumbler Design

Cylinder locks with a pin-and-tumbler design are generally comprised of an outer casing, known as a cylinder, which houses a plug and a pin assembly. The plug further comprises a keyway, and is attached to a cam via a plug nut. In order for the lock to open, the plug must rotate. When the proper key is inserted into the keyway, the plug rotates in a certain direction along with the attached the cam, and the door, secured by the lock, opens. The rotation of the plug in the other direction rotates the cam back into the locked position and closes the door.

In order to permit rotation of the plug, the correct key must be inserted into the keyway of the plug. When the correct key is inserted into the keyway, the pin assembly of the lock moves to a predefined position allowing the plug to rotate. Specifically, the pin assembly in a pin-and-tumbler design cylinder lock consists of a plurality of pins and a plurality of springs, both of varying lengths. Each pin is comprised of a driver pin positioned on top of a tumbler pin. Each driver-tumbler pin pair resides in its own two-part shaft oriented vertically in the cylinder and the plug. In other words, a

plurality of holes exist, one for each pin pair. Springs positioned at the top of each shaft directly above each driver pin keeps each pin pair in place.

Before a key is inserted into the keyway of the plug, the tumbler pin of each pin pair resides completely within the plug. The driver pins of each pin are positioned to be partially in the plug and partially in the cylinder. The position of the driver pins keeps the plug from turning, ensuring that the lock stays locked.

When the correct key is inserted into the keyway, the series of notches in the key push the pin pairs up to different levels. Only the correct key allows each pin pair to move such that the driver pins are positioned completely outside of the plug and are aligned with the shear line of the lock. The shear line of the lock is the point where the cylinder and plug of the lock meet. At the shear line, and with the driver pins positioned completely in the cylinder of the lock, the plug can now move freely, which in turn allows the cam to move freely. This free movement of the plug and cam results in the opening of the lock.

### EMBODIMENTS

Reference will now be made in detail to exemplary embodiments consistent with the invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

Examples of a novel locking apparatus and method are disclosed. Generally, the principles of such a locking apparatus and method are described with respect to wall-mounted lock boxes for mail. However, one skilled in the art will recognize that the principles described below apply to any storage container or box, including personal storage containers, in which a cylinder lock with pin-and-tumbler design may be deployed.

The disclosed lock and associated methods provide both an economical solution to and significant protection against attempts to break into storage containers and help to reduce the incidence of theft. The disclosed lock is improved, has several unique design features and has unique performance capabilities as compared to prior versions of the USPS-L-1172 lock and as compared to other conventional similar locks. The disclosed lock also provides ease of use to the patron of the storage container.

Referring now to FIG. 1, an exemplary lock system **100** consistent with the invention is illustrated. System **100** comprises a cylinder **101** in which a plug **103** resides. A nut **105** captures a cam **107** to the threaded portion **109** of plug **103**. Cam **107** may have various shapes, including a hook shape or an oval shape.

In this embodiment, system **100** uses a five-pin tumbler-style lock, providing ample security in diversity of the key codes, while also readily enabling cutting of a key **111** from blanks using typical cutting tools. Accordingly, system **100** may comprise pin assembly comprising five pairs of pins **113** and five springs **115**. A plug retainer **126** may also be used to affix the plug to the cylinder. A spring retainer **117** may be used to keep the pins **113** and plug retainer **126** in place.

In one embodiment, a spring-hinged stainless steel dust cover **119** may be braced by a spring **121** over the keyhole **125** of plug **103**. A plug cap **123** with a keyhole **125** may be affixed over the dust cover **119** to such that keyhole **125** lines up with keyway **127** of plug **103**. Dust cover **119** may resiliently move from a first position covering the keyhole to a second position uncovering the keyhole. This feature may reduce the opportunity for corrosion and the accumulation of particulates in

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the shaft of the plug. This design may additionally maintain the integrity of the locking mechanism over time, while permitting easy access and manipulation by the patron. Both clockwise and counter-clockwise models of system 100 may be provided.

Referring now to FIGS. 2(a)-(d), various views of an exemplary cylinder 101 are shown. Cylinder 101 may be attached to a collar 215, as shown in FIG. 2(c). Moreover, together with plug 103 (not shown in FIGS. 2(a)-(d)) and plug retainer 126, cylinder 101 forms a lock body 201.

In one embodiment, the shape of lock body 201 may deviate from the industry-standard lock body. Rather than being cylindrical in shape, the shape of lock body 201 may have an arced bottom edge 203, two substantially straight side edges 205, 207 and a straight top edge 211 with two notched portions 209 positioned on the sides of top edge 211 of the cylinder. Notched portions 209 on top edge 211 of cylinder 101 runs down the entire length of cylinder 101. The resulting shape provides the capacity for lock system 100 to accommodate a restrictive hole pattern in addition to the typical mounting hole pattern, a nominal 0.635"x0.750" double-D hole pattern, which has been in use for decades. The unique shape of the lock body 201 prevents older generation double D-shaped locks from being used in newer storage doors that have a mounting hole pattern cutout corresponding to the shape of lock body 201, while still enabling newer lock system 100 to be installed in older storage units.

Consistent with the invention, the profile of collar 215 on cylinder 101 may be beveled to retard gripping about the circumference of the cylinder exposed on the outside of the storage unit. This design may resist, for example, gripping of the cylinder collar with vise grips and removing the lock with torsion force.

Modifying cylinder 101 may be another way to achieve increased security. The following descriptions represent exemplary improvements in the lock design, consistent with the invention.

The cylinder in the prior art 1172C is made from nickel-plated zinc alloy die cast material. Replacing this material with stainless steel materials would allow either (a) the Metal Injection Molding (MIM) method, (b) die cast method with secondary machining, or (c) machining as the fabrication method for this part. This is the same material currently used with the mating plug part, which is manufactured by MIM. Alternate materials, not currently used in the 1172C may also be used in forming the plug and/or the cylinder. These materials include: precipitation-hardened stainless steel in accordance with MPIF standards 35, MIM-17-4 PH, condition H900; and age-hardened stainless steel casting, in accordance with ASTM A 747 grade CB7CU-1, type 17-4, condition H900; and precipitation hardened stainless steel in accordance with ASTM A 564, type 630, condition H900. These materials can provide even more structural integrity of the lock and security.

This material improvement to cylinder 101, coupled with the existing performance of plug 103, may provide for a lock system 100 that not only meets the existing set of strength and security type tests, but may be capable of withstanding additional security testing, such as hammer hits, drilling, etc., to a significantly higher degree. In addition, the use of any of these stainless steel materials may result in a lock system 100 with significant improvement in environmental corrosion resistance over the current nickel-plated, zinc alloy die cast cylinders and result in a longer service life.

Since a lock system consistent with the present invention is somewhat similar in appearance to prior art lock systems, a lock system consistent with the present invention may include

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a distinctive legend, such as a model number, inscribed or otherwise permanently displayed on the face of cylinder 101, for ease of recognition by delivery personnel and storage locker patrons.

Referring now to FIG. 3, plug 103 consistent with the invention is shown. Several novel design features exist in plug 103, which may contribute to the increased security properties of system 100. The prior art USPS-L-1172C lock has a stainless steel plug, which was formed into its configuration through metal injection molding (MIM), providing greatly improved strength over previous versions while maintaining economical production. Accordingly, the prior art lock withstands aggressive torque load to its face without becoming loose or disassociated from the storage container. The prior art locking apparatus comprised a self-locking nut, which did not back off of the end of the plug bolt even when subjected to vibration, cantilever load on the door of the storage container, or tensile load to the face of the cylinder.

Consistent with the invention, a self-locking feature may be provided, using threads 301 of plug 103. In particular a self-locking feature may be incorporated into at least a portion of threads 301 of plug 103 by deforming plug threads 301, such as by notching, crimping, warping, flattening the threads, or by using asymmetrical thread spacing. Alternatively, deformation of plug threads 301 may occur during a metal injection molding process (MIM). Thus, the required strength of the thread-to-thread grip of the plug and nut may be such that any standard nut could be used on plug 103. Deforming plug threads 301 and threading nut 105 thereon causes a retention force to exist between plug threads 301 and nut 105, securing nut 105 to plug 103 such that nut 105 may resist removal from plug threads 301. Thus, nut 105 may not be unintentionally removed from the end of plug 103 due to vibration, cantilever load on the door of the storage container, or tensile load to the face of cylinder 101. This not only may provide easier installation in terms of complexity and effort, but also may provide cost reduction by elimination of the prior art specialized locking nut.

It is desirable for some applications to provide increased resistance to chemical corrosion of the plug. Such corrosion may result from either ambient conditions or deliberate attempts to compromise the lock.

The use of alternate stainless steel materials for plug 103 over prior art plug MIM material may provide diversity in materials, manufacturing, and performance. Selecting the MIM process requires a very large expected production volume to justify the tooling investment. Thus, two stainless steel materials described above as alternate cylinder materials may also be used for plug 103, consistent with the invention. These alternate materials may provide material options to future licensed suppliers that accommodate alternative manufacturing processes for the disclosed plug. Consistent with the invention, the same material from those listed above may be chosen for both plug 103 and cylinder 101.

Referring now to FIG. 4, restrictive mounting hole 213 consistent with the invention is shown. Restrictive mounting hole 213 may be formed into the door of the storage container to be locked. For example, a wall-mounted lock box for mail (not shown) may have restrictive mounting hole 213 cut into its door. Consistent with the invention, lock system 100 may be configured to accommodate restrictive hole pattern 213 in addition to the typical mounting hole pattern, a nominal 0.635"x0.750" double-D hole pattern, which has been in use for decades, because of the unique shape of the lock body 201. Like the shape of the lock body 201, restrictive mounting hole 213 may be other than cylindrical in shape. Restrictive mounting hole 213 may have an arced bottom edge 401, two

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substantially straight side edges **403**, **405**, and a straight top edge **409** with two notched portions **407** on either side of straight top edge **409**.

Referring now to FIG. 5(a)-(b), an exemplary locking system is shown. A lock **501** consistent with the illustrative embodiment shown in FIG. 1 and a retaining clip **503** may be mounted to storage containers, including lockers, wall-mounted lockers, wall-mounted boxes for mail, or the like. Moreover, lock **501** may be mounted to a plurality of storage containers comprising a cluster box unit. The storage container (not shown), lock **501**, retaining clip **503**, and restrictive mounting hole **213** consistent with the restrictive mounting hole shown in FIG. 4 (not shown in FIGS. 5(a)-(b)) may make up an exemplary system.

Consistent with the invention, retaining clip **503** comprises a substantially U-shaped bracket **505** that may be connected to a rectangular mounting piece **507** at a 90 degree angle. U-shaped bracket **505** may have an outer U-shaped edge **509** and an inner U-shaped edge **511**. Rectangular mounting piece **507** may have a hole **513** cut out from the middle of the piece. Retaining clip **503** may be made out of a variety of materials. For example, steel with a zinc coating may be used.

Collar **215** may be inserted on lock **501**. Lock **501** may then be inserted into restrictive mounting hole **213** (not shown in FIG. 5), which may be cut into the face of the storage container door (not shown). Retaining clip **503** may then be slid onto lock **501** such that lock **501** is positioned to sit in inner U-shaped edge **511** and retaining clip **503** is positioned between lock **501** and the back side of the storage container door. Cam **107** may then be placed in proximity to threaded portion **109** of plug **103**. Mounting a threaded fastener, such as by threading nut **105** onto threaded portion **109** of plug **103**, completes the mounting of lock **501**. Lock **501** may not have collar **215**. Mounting lock **501** without collar **215** may involve all of the steps described above except for the first step of inserting collar **215** on lock **501**.

Referring now to FIG. 6, a flow chart of an exemplary method for making a plug is shown. Consistent with the illustrative embodiments, the flow chart will be described with reference to the lock shown in FIG. 1. The first step in the process **610** may involve forming plug **103**. Plug **103** may be formed, for example, by the metal injection molding (MIM) method, the die cast method with secondary machining, or machining as the fabrication method. Next, in stage **620**, keyway **127** may be formed. In stage **630**, slots, such as holes or shafts, for receiving pin assembly **113** may be formed, by, for example, drilling a series of holes vertically into plug **103**. Stage **640** may involve forming threaded portion **109** of plug **103**. Threaded portion **109** may be deformed so as to provide a retention force when receiving nut **105** to resist removal of nut **105** from threaded portion **109**. If plug **103** is formed using the MIM method, stages **620** through **640** may be performed at stage **610** with the precursor step of injecting mold material, such as stainless steel, into a mold of plug **103** having slots for receiving pin assembly **113** and threaded portion **109**. In this embodiment, the portion of the mold of plug **103** corresponding to threaded portion **109** may have at least one deformed thread.

Referring now to FIG. 7, a flow chart of an exemplary method for mounting a locking apparatus is shown. Consistent with the illustrative embodiments, the flow chart will be described with reference to the system shown in FIG. 5, the lock shown in FIG. 1, and the restrictive mounting hole shown in FIG. 4. Stage **710** may involve inserting collar **215** onto lock **501**. Stage **710** may be optional, depending on whether lock **501** has collar **215**. Next, in stage **720**, lock **501** may be inserted through a hole in the door of a storage container.

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Stage **720** may be achieved by cutting restrictive mounting hole **213** and inserting lock **501** into restrictive mounting hole **213**. Stage **730** may involve capturing lock **501** with a retaining clip. Stage **730** may include the step of inserting lock **501** into retaining clip **503**, thereby affixing lock **501** onto the storage container door. Next, in stage **740**, cam **107** may be placed on plug **103** in proximity to threaded portion **109**. Stage **750** involves mounting a threaded fastener, such as by threading nut **105** onto threaded portion **109** of plug **103**. Threaded portion **109** may be deformed so as to provide a retention force when nut **105** to resist removal of nut **105** from threaded portion **109**.

Other embodiments of the invention will be apparent to those skilled in the art from consideration of the specification and practice of the invention disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope and spirit of the invention being indicated by the following claims.

What is claimed is:

1. A locking apparatus for locking a box using a cam, comprising:
  - a cylinder;
  - a rotatable plug positioned inside the cylinder and having a threaded portion;
  - a pin assembly for receiving a key to selectably prevent and permit rotation of the plug; and
  - a nut cooperating with the threaded portion of the plug to capture the cam, wherein:
    - the cylinder and plug form a lock body having a non-cylindrical shape, the lock body including a top edge and an arcuate bottom edge, two substantially straight side edges extending from the arcuate bottom edge to an intermediate edge, and two notched portions, the notched portions extending into the lock body from the substantially straight side edges, and extending vertically from the top edge to the intermediate edge along the length of the cylinder;
    - the non-cylindrical shape is configured to fit a non-cylindrical restrictive mounting hole pattern and a cylindrical mounting hole pattern; and
    - at least one of the threads of the threaded portion is deformed, providing a retention force between the threaded portion of the plug and the nut to resist removal of the nut from the threaded portion.
2. The locking apparatus of claim 1, wherein the cylinder is made of a stainless steel material.
3. The locking apparatus of claim 2, wherein the stainless steel material comprises a material selected from the group consisting of metal-injection-molded stainless steel, precipitation-hardened stainless steel, precipitation-hardened stainless steel casting, or age-hardened stainless steel.
4. The locking apparatus of claim 1, wherein the plug is made of a stainless steel material.
5. The locking apparatus of claim 4, wherein the stainless steel material comprises a material selected from the group consisting of metal-injection-molded stainless steel, precipitation-hardened stainless steel, precipitation-hardened stainless steel casting, or age-hardened stainless steel.
6. The locking apparatus of claim 1, wherein the cylinder comprises a collar having a bevel.
7. The locking apparatus of claim 1, further comprising a spring-hinged dust cover, and wherein:
  - the plug comprises means defining a keyhole, the keyhole being disposed opposite from the threaded portion of the plug, and

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the dust cover is resiliently movable from a first position covering the keyhole to a second position exposing the keyhole.

8. The locking apparatus of claim 1, wherein the lock body further comprises an arced bottom.

9. The locking apparatus of claim 1, wherein the deformed thread comprises at least one of a crimped or warped thread, or asymmetrical thread spacing.

10. A locking apparatus for a wall-mounted box using a cam, comprising:

a cylinder comprising a stainless steel material;

a rotatable plug positioned inside the cylinder and having a threaded portion, the plug formed of a stainless steel material;

a pin assembly for receiving a key to selectably prevent and permit rotation of the plug; and

a nut cooperating with the threaded portion of the plug to capture the cam, wherein:

the cylinder and plug form a lock body having a non-cylindrical shape, the lock body including a top edge and an arcuate bottom edge, two substantially straight side edges extending from the arcuate bottom edge to an intermediate edge, and two notched portions, the notched portions extending into the lock body from the substantially straight side edges, and extending vertically from the top edge to the intermediate edge along the length of the cylinder;

the non-cylindrical shape is configured to fit a non-cylindrical restrictive mounting hole pattern and a cylindrical mounting hole pattern; and

at least one of the threads of the threaded portion is deformed, providing a retention force between the threaded portion of the plug and the nut to resist removal of the nut from the threaded portion.

11. The locking apparatus of claim 10, wherein the stainless steel material of the cylinder comprises a material selected from the group consisting of metal-injection-molded stainless steel, precipitation-hardened stainless steel, precipitation-hardened stainless steel casting, or age-hardened stainless steel.

12. The locking apparatus of claim 10, wherein the stainless steel material of the plug comprises a material selected from the group consisting of metal-injection-molded stainless steel, precipitation-hardened stainless steel, precipitation-hardened stainless steel casting, or age-hardened stainless steel.

13. The locking apparatus of claim 10, further comprising a spring-hinged dust cover, and wherein:

the plug comprises means defining a keyhole, the keyhole being disposed opposite from the threaded portion of the plug, and

the dust cover is resiliently movable from a first position covering the keyhole to a second position exposing the keyhole.

14. The locking apparatus of claim 10, wherein the lock body further comprises an arced bottom.

15. The locking apparatus of claim 10, wherein the deformed thread comprises at least one of a crimped or warped thread, or asymmetrical thread spacing.

16. The locking apparatus of claim 10, wherein the cylinder comprises a collar, the collar having a bevel.

17. A locking apparatus for a wall-mounted mail box using a cam, comprising,

a cylinder having a beveled collar, the cylinder being comprised of a material selected from the group consisting of metal-injection-molded stainless steel, precipitation-

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hardened stainless steel, precipitation-hardened steel casting, or age-hardened stainless steel;

a rotatable plug positioned inside the cylinder and having a threaded portion, the plug being comprised of a material selected from the group consisting of metal-injection-molded stainless steel, precipitation-hardened stainless steel, precipitation-hardened steel casting, or age-hardened stainless steel;

a pin assembly for receiving a key to selectably prevent and permit rotation of the plug; and

a nut cooperating with the threaded portion of the plug to capture the cam,

wherein:

the cylinder and plug form a lock body having a non-cylindrical shape, the lock body including a top edge and an arcuate bottom edge, two substantially straight side edges extending from the arcuate bottom edge to an intermediate edge, and two notched portions, the notched portions extending into the lock body from the substantially straight side edges, and extending vertically from the top edge to the intermediate edge along the length of the cylinder;

the non-cylindrical shape is configured to fit a non-cylindrical restrictive mounting hole pattern and a cylindrical mounting hole pattern; and

at least one of the threads of the threaded portion is deformed, providing a retention force between threaded portion of the plug and the nut to resist removal of the nut from the threaded portion.

18. The locking apparatus of claim 17, wherein the plug and the cylinder are made of the same material.

19. The locking apparatus of claim 17, further comprising a spring-hinged dust cover, and wherein:

the plug comprises means defining a keyhole, the keyhole being disposed opposite from the threaded portion of the plug, and

the dust cover is resiliently movable from a first position covering the keyhole to a second position exposing the keyhole.

20. The locking apparatus of claim 17, wherein the lock body further comprises an arced bottom.

21. The locking apparatus of claim 17, wherein the deformed thread comprises at least one of a crimped or warped thread, or asymmetrical thread spacing.

22. A plug for use in locking a locking apparatus for a door of a storage container, the locking apparatus comprising a cylinder and a cam, the plug comprising:

a plug body insertable into the cylinder; and

a threaded portion of the plug body having a deformed thread, the deformed thread receiving a nut so as to form a retention force between the deformed thread and the nut to resist removal of the nut from the threaded portion, wherein:

the cylinder and plug form a lock body having a non-cylindrical shape, the lock body including a top edge and an arcuate bottom edge, two substantially straight side edges extending from the arcuate bottom edge to an intermediate edge, and two notched portions, the notched portions extending into the lock body from the substantially straight side edges, and extending vertically from the top surface edge to the intermediate edge along the length of the cylinder; and

the non-cylindrical shape is configured to fit a non-cylindrical restrictive mounting hole pattern and a cylindrical mounting hole pattern.

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23. The plug of claim 22, wherein the deformed thread comprises at least one of a crimped or warped thread, or asymmetrical thread spacing.

24. The plug of claim 22, wherein the plug is comprised of a material selected from the group consisting of metal-injection-molded stainless steel, precipitation-hardened stainless steel, precipitation-hardened steel casting, or age-hardened stainless steel.

25. A mail storage container for use in a cluster box unit having a plurality of mail storage containers, each mail storage container comprising

a lock, the lock comprising

a cylinder;

a rotatable plug positioned inside the cylinder and having a threaded portion;

a pin assembly for receiving a key to selectably prevent and permit rotation of the plug; and

a nut cooperating with the threaded portion of the plug to capture a cam, wherein

the cylinder and plug form a lock body having a non-cylindrical shape, the lock body including a top edge and an arcuate bottom edge, two substantially straight side edges extending from the arcuate bottom edge to an intermediate edge, and two notched portions, the notched portions extending into the lock body from the substantially straight side edges, and extending vertically from the top edge to the intermediate edge along the length of the cylinder;

the non-cylindrical shape is configured to fit a non-cylindrical restrictive mounting hole pattern and a cylindrical mounting hole pattern; and

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at least one of the threads of the threaded portion is deformed, providing a retention force between the threaded portion of the plug and the nut to resist removal of the nut from the threaded portion;

a door;

a restrictive mounting hole formed on the face of the door; and

a retaining clip for mounting the lock to the door positioned between the restrictive mounting hole and the lock.

26. A method for making a locking apparatus, comprising: forming a lock cylinder;

forming a lock plug including a threaded portion, the threaded portion having at least one deformed thread so as to provide a retention force when receiving a nut to resist removal of the nut from the threaded portion;

inserting the lock plug into the lock cylinder; and

inserting a plug retainer into the lock cylinder to retain the lock plug, wherein:

the cylinder and plug form a lock body having a non-cylindrical shape, the lock body including a top edge and an arcuate bottom edge, two substantially straight side edges extending from the arcuate bottom edge to an intermediate edge, and two notched portions, the notched portions extending into the lock body from the substantially straight side edges, and extending vertically from the top edge to the intermediate edge along the length of the cylinder; and

the non-cylindrical shape is configured to fit a non-cylindrical restrictive mounting hole pattern and a cylindrical mounting hole pattern.

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